

The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 October 2001.

INCH-POUND

MIL-PRF-19500/534C
31 July 2001
SUPERSEDING
MIL-PRF-19500/534B
30 December 1997

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
TYPES 2N5002, 2N5004, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, power transistors for use in high-speed power-switching applications. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. Two levels of product assurance for each unencapsulated device type die.

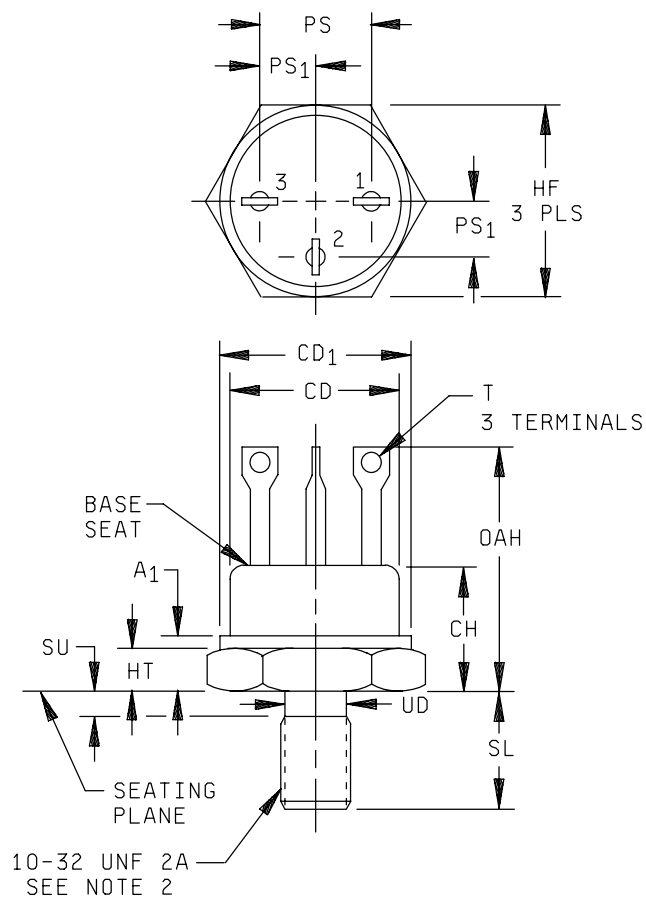
1.2 Physical dimensions. See figure 1 (T6-C, similar to T0-59) and figure 2 (die).

* 1.3 Maximum ratings.

| P_T (1) $T_A = 25^\circ\text{C}$ | P_T (2) $T_C = 25^\circ\text{C}$ | V_{CBO} | V_{CEO} | V_{EBO} | I_C | I_C (3) | Reverse pulse energy | T_{stg} and T_J |
|---------------------------------------|---------------------------------------|-------------|-------------|-------------|-------------|-------------|----------------------------|---------------------|
| <u>W</u> | <u>W</u> | <u>V dc</u> | <u>V dc</u> | <u>V dc</u> | <u>A dc</u> | <u>A dc</u> | <u>mJ</u> | <u>°C</u> |
| 2 | 58 | 100 | 80 | 5.5 | 5 | 10 | 15 | -65 to +200 |

- (1) Derate linearly 11.4 mW/°C for $T_A > 25^\circ\text{C}$.
- (2) Derate linearly 331 mW/°C for $T_C > 25^\circ\text{C}$.
- (3) This value applies for $P_w \leq 8.3$ ms, duty cycle ≤ 1 percent.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

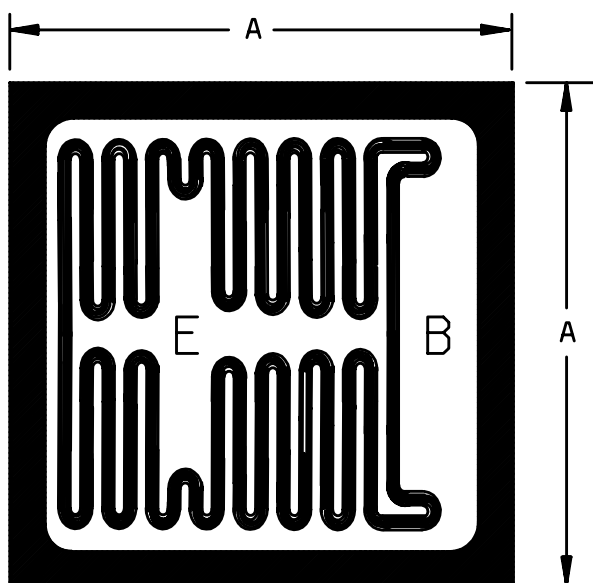


| Ltr | Dimension | | | | Notes |
|-----------------|-----------|------|-------------|-------|-------|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| A ₁ | | .250 | | 6.35 | |
| CD | .330 | .360 | 8.38 | 9.14 | |
| CD ₁ | .370 | .437 | 9.40 | 11.10 | |
| CH | .320 | .468 | 8.13 | 11.80 | |
| HF | .424 | .437 | 10.77 | 11.10 | |
| HT | .090 | .150 | 2.67 | 3.81 | |
| OAH | .575 | .763 | 14.61 | 19.40 | 4 |
| PS | .185 | .215 | 4.70 | 5.46 | 3, 6 |
| PS ₁ | .090 | .110 | 2.29 | 2.79 | 3, 6 |
| SL | .400 | .455 | 10.16 | 11.56 | |
| SU | | .078 | | 1.98 | 7 |
| T | .040 | .065 | 1.02 | 1.65 | |
| UD | .155 | .189 | 3.94 | 4.80 | |

NOTES:

1. Dimensions are in inches. Metric equivalents are given for general information only.
2. See NSB Handbook H28, "Screw-Thread Standards for Federal Services".
3. The orientation of the terminals in relation to the hex flats is not controlled.
4. All three terminals.
5. The case temperature may be measured anywhere on the seating plane within .125 inch (3.18 mm) of the stud.
6. Terminal spacing measured at the base seat only.
7. This dimension applies to the location of the center line of the terminals.
8. Terminal - 1, emitter; terminal - 2, base; terminal - 3, collector. Collector lead is isolated from the case.

FIGURE 1. Physical dimensions of transistor types 2N5002 and 2N5004 (T6-C, similar to T0-59).



| Ltr | Dimensions | | | |
|-----|------------|------|-------------|------|
| | Inches | | Millimeters | |
| | Min | Max | Min | Max |
| A | .117 | .127 | 2.97 | 3.23 |

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is $\pm .005$ (0.13 mm).
4. The physical characteristics of the die are;
 Thickness: .008 (0.20 mm) to .012 (0.30 mm), tolerance is $\pm .005$ (0.13 mm)
 Top metal: Aluminum, 40,000 Å minimum, 50,000 Å nominal.
 Back metal: Gold 2,500 Å minimum, 3,000 Å nominal.
 Back side: Collector.
 Bonding pad: B = .015 (0.38 mm) x .0072 (.183). E = .015 (0.38 mm) x .0060 (.152).

*FIGURE 2. Physical dimensions JANHCA and JANKCA die dimensions.

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1.4 Primary electrical characteristics at $T_C = +25^\circ\text{C}$.

| Limits | h_{FE2} (1) $V_{CE} = 5\text{ V}$ $I_C = 2.5\text{ A}$ | | $ h_{fe} $ $V_{CE} = 5\text{ V}$ $I_C = 500\text{ mA dc}$ $f = 10\text{ MHz}$ | | $V_{BE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$ | $V_{CE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$ | C_{obo} $V_{CB} = 10\text{ V dc}$ $I_E = 0$ $f = 1\text{ MHz}$ | $R_{\theta JA}$ | $R_{\theta JC}$ |
|--------|--|--------|--|--------|---|---|---|--------------------------------------|--------------------------------------|
| | 2N5002 | 2N5004 | 2N5002 | 2N0004 | | | | | |
| Min | 30 | 70 | 6 | 7 | <u>V dc</u> | <u>V dc</u> | <u>pF</u> | <u>$^\circ\text{C/W}$</u> | <u>$^\circ\text{C/W}$</u> |
| Max | 90 | 200 | | | 2.2 | 1.5 | 250 | 88 | 3 |

(1) Pulsed (see 4.5.1)

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The requirements for acquiring the product described herein shall consist of this document and MIL-PRF-19500.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and herein.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (T6-C, similar to TO-59) and 2 (die) herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4 and table I herein.

3.6.1 Current density. Current density of internal conductors shall be as specified in MIL-PRF-19500.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.

* 3.8 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 JANHC and JANKC qualification. JANHC and JANKC qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table IV of MIL-PRF-19500 (table IV), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

| Screen (see table IV of MIL-PRF-19500) | Measurement | |
|--|---|--|
| | JANS level | JANTX and JANTXV levels |
| (1) | Thermal impedance (see 4.3.2) | Thermal impedance (see 4.3.2) |
| 9 | I_{CES1} and h_{FE2} | Not applicable |
| 11 | $\Delta I_{CES1} = 100$ percent or 100 nA, whichever is greater; $\Delta h_{FE2} = \pm 20$ percent | I_{CES1} and h_{FE2} |
| 12 | See 4.3.1 | See 4.3.1 |
| 13 | Subgroups 2 and 3 of table I herein; $\Delta I_{CES1} = +100$ percent of initial value or 100 nA, whichever is greater. $\Delta h_{FE2} = \pm 20$ percent | Subgroup 2 of table I herein; $\Delta I_{CES1} = +100$ percent of initial value or 100 nA, whichever is greater. $\Delta h_{FE2} = \pm 20$ percent |

(1) May be performed anytime before screen 9.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in the general requirements of 4.5 of MIL-STD-750. $V_{CE} = 40\text{ V} \pm 1\text{ V}$, $P_T = 2.0\text{ W(min)}$. NOTE: No heat sink or forced air cooling on the device shall be permitted.

4.3.2 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ measurements shall be performed in accordance with method 3131 of MIL-STD-750. The maximum limit (not to exceed the group A, subgroup 2 limit) for $Z_{\theta JX}$ in screening (table IV of MIL-PRF-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X, R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for engineering evaluation and disposition.

4.3.2.1 Thermal impedance ($Z_{\theta JX}$ measurements) for qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with method 3131 of MIL-STD-750. $Z_{\theta JX}$ shall be supplied on one lot (500 devices minimum and a thermal response curve shall be submitted). Twenty-two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurement conditions shall be in accordance with 4.4.1 herein.

* 4.3.3 Screening (JANH or JANKC). Screening of die shall be in accordance with MIL-PRF-19500. As a minimum, die shall be 100-percent probed to ensure compliance with group A, subgroup 2. Burn-in duration for lot acceptance for the JANKC level follows JANS requirements. Burn-in duration for lot acceptance for the JANHC level follows JANTX requirements.

* 4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. If alternate screening is being performed in accordance with E.5.3.1d of MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of group A1 and A2 inspection only (table VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

* 4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table V of MIL-PRF-19500 and table I herein. End-point electrical measurements shall be in accordance with the applicable steps of table II herein. The following test conditions shall be used for $Z_{\theta JA}$ end-point measurements: $Z_{\theta JA} = 10^{\circ}\text{C/W}$.

- a. I_M 10 mA.
- b. V_{CE} measurement voltage..... 20 V (same as V_H).
- c. I_H collector heating current 1 A (minimum).
- d. V_H collector-emitter heating voltage..... 20 V (minimum).
- e. t_H heating time 100 ms.
- f. t_{MD} measurement delay time 50 μs to 80 μs .
- g. t_{SW} sample window time 10 μs (maximum).

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta requirements shall be in accordance with the steps of table II herein as specified in the notes for table II. See 4.4.2.2 herein for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) for JAN, JANTX, and JANTXV shall be after each step in 4.4.2.2 and shall be in accordance with group A, subgroup 2. Delta requirements shall be in accordance with the steps of table II herein as specified in the notes for table II.

4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u> |
|-----------------|---------------|---|
| B4 | 1037 | $V_{CB} = 10\text{ V dc}$ minimum, $P_T = 2.5\text{ W}$ minimum, $T_A = +25^{\circ}\text{C} \pm 3^{\circ}\text{C}$; $t_{on} = t_{off} = 3$ minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted. |
| B5 | 1027 | $V_{CB} = 20\text{ V dc}$, $T_J = +275^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 96 hours; Adjust the chosen T_A and P_T to give an average lot $T_J = +275^{\circ}\text{C}$. Marking legibility requirements shall not apply. |
| B6 | 3131 | See 4.5.2 herein. |

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* 4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. For rules on resubmission for failed steps, see MIL-PRF-19500 rules on resubmission of failed subgroups.

| <u>Step</u> | <u>Method</u> | <u>Condition</u> |
|-------------|---------------|---|
| 1 | 1039 | Steady-state life: Test condition B, 340 hours, $V_{CB} = 10 - 30 \text{ V dc}$. $n = 45$ devices, $c = 0$. Power shall be applied to the device to achieve a $P_T = 2.0 \text{ W(min)}$. |
| 2 | 1039 | Steady-state life test of step 1 shall be extended to 1,000 hours for each die design. Samples shall be selected from a wafer lot every twelve months of wafer production. Group B, step 2 shall not be required more than once for any single wafer lot. $n = 45$ devices, $c = 0$. |
| 3 | 1032 | High-temperature life (non-operating), $T_A = +200^\circ\text{C}$ $n = 22$, $c = 0$. |

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- For JAN, JANTX and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer. For JANS, samples shall be selected from each inspection lot. See MIL-PRF-19500.
- Must be chosen from an inspection lot that has been submitted to and passed group A, subgroup 2 conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (subgroups B4 and B5 for JANS, and group B for JAN, JANJ, JANTX and JANTXV) may be pulled prior to the application of final lead finish.

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta requirements shall be in accordance with the steps of table II herein as specified in the notes for table II.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u> |
|-----------------|---------------|---|
| C2 | 2036 | Tension: Test condition A, weight = 7 pounds, ± 5 ounces, application time = 15 s. Terminal torque: Test condition D1, torque = 6 inch - ounce application time = 15 s. Stud torque: Test condition D2, torque = 15 inch - pounds, application time = 15 s. |
| C6 | 1026 | $V_{CB} = 40 \text{ V dc} \pm 1 \text{ V dc}$, $T_A = \text{room ambient as defined in 4.5 of MIL-STD-750}$. $P_T = 2 \text{ W}$, 1,000 hours. |

* 4.4.3.1 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for C6 life test may be pulled prior to the application of final lead finish. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

* 4.4.4. Group E Inspection. Group E inspection shall be performed in accordance with the tests and conditions specified for subgroup testing in table IX of MIL-PRF-19500 and table III herein for qualification or re-qualification only. In case qualification was awarded to a prior revision of the slashsheet that did not request the performance of table III tests, the tests specified in table III herein must be performed to maintain qualification.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurements shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

- a. Collector current magnitude during power application shall be 2 A dc.
- b. Collector to emitter voltage magnitude shall be 10 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference temperature measuring point shall be within the range $+25^{\circ}\text{C} \leq T_C \leq +75^{\circ}\text{C}$. (Actual temperature shall be recorded.)
- e. Mounting arrangement shall be with heat sink to case.
- f. Maximum limit of $R_{\theta JC}$ shall be 3.0°C/W .

4.5.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted at a case temperature (T_C) of $+25^{\circ}\text{C}$.

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TABLE I. Group A inspection.

| Inspection <u>1</u> / | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|-------------|--|----------------------|--------|-----|-------|
| | Method | Conditions | | Min | Max | |
| * <u>Subgroup 1 2</u> / | | | | | | |
| Visual and mechanical <u>3</u> / examination | 2071 | n = 45 devices, c = 0 | | | | |
| Solderability <u>3</u> / <u>4</u> / | 2026 | n = 15 leads, c = 0 | | | | |
| Resistance to solvents <u>3</u> / <u>4</u> / <u>5</u> / | 1022 | n = 15 devices, c = 0 | | | | |
| Temp Cycling <u>3</u> / <u>4</u> / | 1051 | Test condition C, 25 cycles. n = 22 devices, c = 0 | | | | |
| Hermetic Seal <u>4</u> / Fine leak Gross leak | 1071 | n = 22 devices, c = 0 | | | | |
| Electrical measurements <u>4</u> / Bond strength <u>3</u> / <u>4</u> / | 2037 | Group A, subgroup 2 Precondition T _A = +250°C at t = 24 hrs or T _A = +300°C at t = 2 hrs n = 11 wires, c = 0 | | | | |
| <u>Subgroup 2</u> | | | | | | |
| * Thermal impedance | 3131 | See 4.4.1 | | | 10 | °C/W |
| Breakdown voltage, collector to emitter | 3011 | Bias condition D, I _C = 100 mA dc I _B = 0, pulsed (see 4.5.1) | V _{(BR)CEO} | 80 | | V dc |
| Collector to emitter cutoff current | 3041 | Bias condition C, V _{CE} = 60 V dc, V _{BE} = 0 | I _{CES1} | | 1.0 | μA dc |
| Collector to emitter cutoff current | 3041 | Bias condition C, V _{CE} = 100 V dc, V _{BE} = 0 | I _{CES2} | | 1.0 | mA dc |
| Collector to emitter cutoff current | 3041 | Bias condition D, V _{CE} = 40 V dc, I _B = 0 | I _{CEO} | | 50 | μA dc |
| Emitter to base cutoff current | 3061 | Bias condition D, V _{BE} = 4 V dc, I _C = 0 | I _{EBO1} | | 1.0 | mA dc |
| Emitter to base cutoff current | 3061 | Bias condition D, V _{EB} = 5.5 V dc, I _C = 0 | I _{EBO2} | | 1.0 | mA dc |

See footnote at end of table.

TABLE I. Group A inspection. - Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|--|-------------|--|-----------------------|----------|-----------|-------|
| | Method | Conditions | | Min | Max | |
| <u>Subgroup 2</u> - Continued | | | | | | |
| Forward - current transfer ratio 2N5002 2N5004 | 3076 | V _{CE} = 5 V dc, I _C = 50 mA dc | h _{FE1} | 20 50 | | |
| Forward - current transfer ratio 2N5002 2N5004 | 3076 | V _{CE} = 5 V dc, I _C = 2.5 A dc pulsed (see 4.5.1) | h _{FE2} | 30 70 | 90 200 | |
| Forward - current transfer ratio 2N5002 2N5004 | 3076 | V _{CE} = 5 V dc, I _C = 5 A dc pulsed (see 4.5.1) | h _{FE3} | 20 40 | | |
| Base-emitter voltage (non-saturated) | 3066 | Test condition B, V _{CE} = 5 V dc, I _C = 2.5 A dc, pulsed (see 4.5.1) | V _{BE} | | 1.45 | V dc |
| Base-emitter saturation voltage | 3066 | Test condition A, I _C = 2.5 A dc, I _B = 250 mA dc, pulsed (see 4.5.1) | V _{BE(sat)1} | | 1.45 | V dc |
| Base-emitter saturation voltage | 3066 | Test condition A, I _C = 5 A dc, I _B = 500 mA dc, pulsed (see 4.5.1) | V _{BE(sat)2} | | 2.2 | V dc |
| Collector-emitter saturation voltage | 3071 | I _C = 2.5 A dc, I _B = 250 mA dc pulsed (see 4.5.1) | V _{CE(sat)1} | | 0.75 | V dc |
| Collector-emitter saturation voltage | 3071 | I _C = 5 A dc, I _B = 500 mA dc pulsed (see 4.5.1) | V _{CE(sat)2} | | 1.5 | V dc |
| <u>Subgroup 3</u> | | | | | | |
| High-temperature operation: | | T _C = +150°C | | | | |
| Collector to emitter cutoff current | 3041 | Bias condition A, V _{CE} = 60 V dc V _{BE} = -2 V dc | I _{CEX} | | 500 | µA dc |
| Low-temperature operation: | | T _C = -55°C | | | | |
| Forward - current transfer ratio 2N5002 2N5004 | 3076 | V _{CE} = 5 V dc, I _C = 2.5 A dc pulsed (see 4.5.1) | h _{FE4} | 15 25 | | |

See footnotes at end of table.

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TABLE I. Group A inspection. - Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|--|-------------|---|---|----------|--------------------------|--|
| | Method | Conditions | | Min | Max | |
| <u>Subgroup 4</u> | | | | | | |
| Common-emitter, small-signal, short-circuit, forward-current transfer ratio 2N5002 2N5004 | 3206 | $V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ mA dc}$ $f = 1 \text{ kHz}$ | h_{fe} | 20 50 | | |
| Magnitude of common-emitter, small-signal short-circuit, forward-current, transfer ratio 2N5002 2N5004 | 3206 | $V_{CE} = 5 \text{ V dc}$, $I_C = 500 \text{ mA dc}$ $f = 10 \text{ MHz}$ | $ h_{fe} $ | 6 7 | | |
| Open-circuit output capacitance | 3236 | $V_{CB} = 10 \text{ V dc}$ | C_{obo} | | 250 | pF |
| * Switching time | | $I_C = 5 \text{ A dc}$, $I_{B1} = 500 \text{ mA dc}$, $I_{B2} = -500 \text{ mA dc}$, $V_{BE(off)} = 3.7 \text{ V dc}$, $R_L = 6 \Omega$, see figure 3 | t_{on} t_s t_f t_{off} | | 0.5 1.4 0.5 1.5 | μs μs μs μs |
| * <u>Subgroup 5</u> | | | | | | |
| Safe operating area (D.C.) | 3055 | Pre-pulse condition for each test: $V_{CE} = 0$, $I_C = 0$, $T_C = +25^\circ\text{C}$ Pulse condition for each test $t_p = 1 \text{ second 1 cycle}$ | | | | |
| Test #1 | | $V_{CE} = 12 \text{ V dc}$, $I_C = 5 \text{ A dc}$ | | | | |
| Test #2 | | $V_{CE} = 32 \text{ V dc}$, $I_C = 1.7 \text{ A dc}$ | | | | |
| Test #3 | | $V_{CE} = 80 \text{ V dc}$, $I_C = 100 \text{ mA dc}$ | | | | |

See footnotes at end of table.

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TABLE I. Group A inspection. - Continued.

| Inspection <u>1</u> / | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|-------------|---|--------|--------|-----|------|
| | Method | Conditions | | Min | Max | |
| <u>Subgroup 5</u> Continued Safe operating area (unclamped inductive) * End-point electrical measurements <u>Subgroups 6 and 7</u> Not applicable | | $T_C = +25^{\circ}\text{C}$, $R_{BB1} = 10\ \Omega$, $R_{BB2} = 100\ \Omega$, $L = 0.3\ \text{mH}$, $R_L = 0.1\ \Omega$, $V_{CC} = 10\ \text{V dc}$, $V_{BB1} = 10\ \text{V dc}$, $V_{BB2} = 4\ \text{V dc}$, $I_{CM} = 10\ \text{A dc}$ (See figure 4). See table I, group A, subgroup2 herein. | | | | |

1/ For sampling plan see MIL-PRF-19500.

2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.

3/ Separate samples may be used.

4/ Not required for JANS devices.

5/ Not required for laser marked devices.

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*TABLE II. Groups B and C delta measurements. 1/ 2/ 3/

| Steps | Inspection <u>4/</u> | MIL-STD-750 | | Symbol | Limits | | Unit0 |
|-------|-------------------------------------|-------------|---|------------------------------|---|------|-------|
| | | Method | Conditions | | Min | Max | |
| 1. | Collector to emitter cutoff current | 3041 | V _{CE} = 60 V dc | ΔI _{CES1} <u>4/</u> | 100 percent of initial value or 100 nA, whichever is greater. | | |
| 2. | Forward - current transfer ratio | 3076 | I _C = 2.5 A dc V _{CE} = 5 V dc, pulsed (see 4.5.1) | Δh _{FE2} <u>4/</u> | ± 20 percent change from initial reading | | |
| 3. | Base to emitter saturation voltage | 3066 | Test condition A, I _C = 2.5 A dc I _B = 250 mA dc, pulsed (see 4.5.1) | V _{BE(sat)} | | 1.45 | V dc |

1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:

- Subgroup 3, see table II herein, step 3.
- Subgroup 4, see table II herein, steps 1, 2, and 3.

2/ The delta measurements for group B, (see 4.4.2.2 herein, JAN, JANTX, and JANTXV) are as follows: After each step in 4.4.2.2, see table II herein, steps 1 and 2.

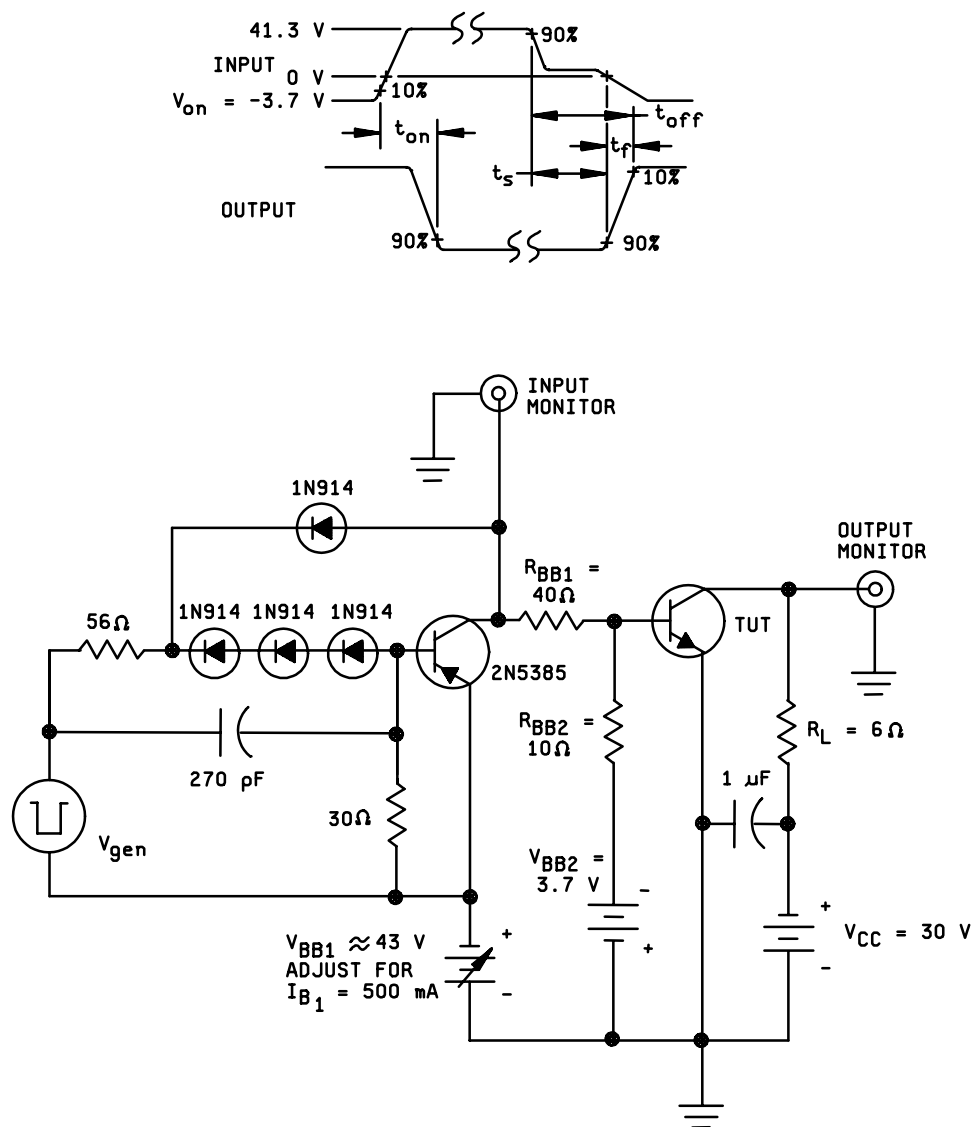
3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroups 3 and 6, see table II herein, steps 1 and 2.

4/ Devices which exceed the Group A limits for this test shall not be accepted.

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*TABLE III. Group E inspection (all quality levels) - For qualification only.

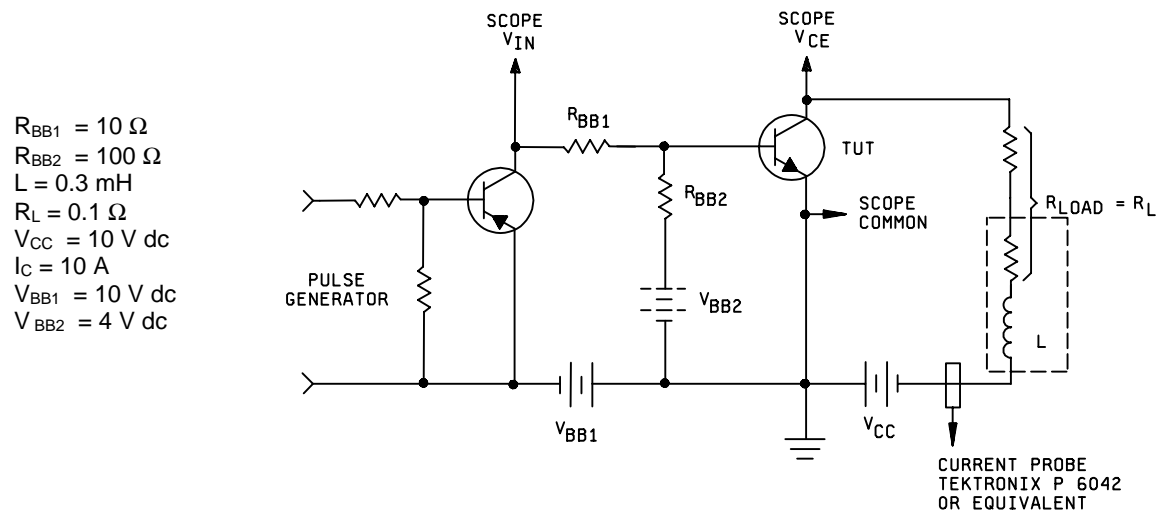
| Inspection | MIL-STD-750 | | Qualification |
|-------------------------------------|-------------|---|---------------------|
| | Method | Conditions | |
| <u>Subgroup 1</u> | | | 12 devices c = 0 |
| Temperature cycling (air to air) | 1051 | | |
| Hermetic seal | 1071 | Test condition C, 500 cycles | |
| Fine leak | | | |
| Gross leak | | | |
| Electrical measurements | | See group A, subgroup 2 herein. | |
| <u>Subgroup 2</u> | | | 45 devices c = 0 |
| Intermittent life | 1037 | Intermittent operation life: $V_{CB} = 10 \text{ V dc}$, 6000 cycles | |
| Electrical measurements | | See group A, subgroup 2 herein. | |
| <u>Subgroups 3, 4, and 5</u> | | | |
| Not applicable | | | |



NOTES:

1. V_{gen} is a -30 pulse (from 0 V) into a 50 ohm termination.
2. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50$ ohm, duty cycle ≤ 2 percent.
3. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ M Ω , $C_{in} \leq 11.5$ pF.
4. Resistors must be noninductive types.
5. The dc power supplies may require additional bypassing in order to minimize ringing.
6. An equivalent circuit may be used.

FIGURE 3. Switching time test circuit.

FIGURE 4. Unclamped inductive load energy test circuit.

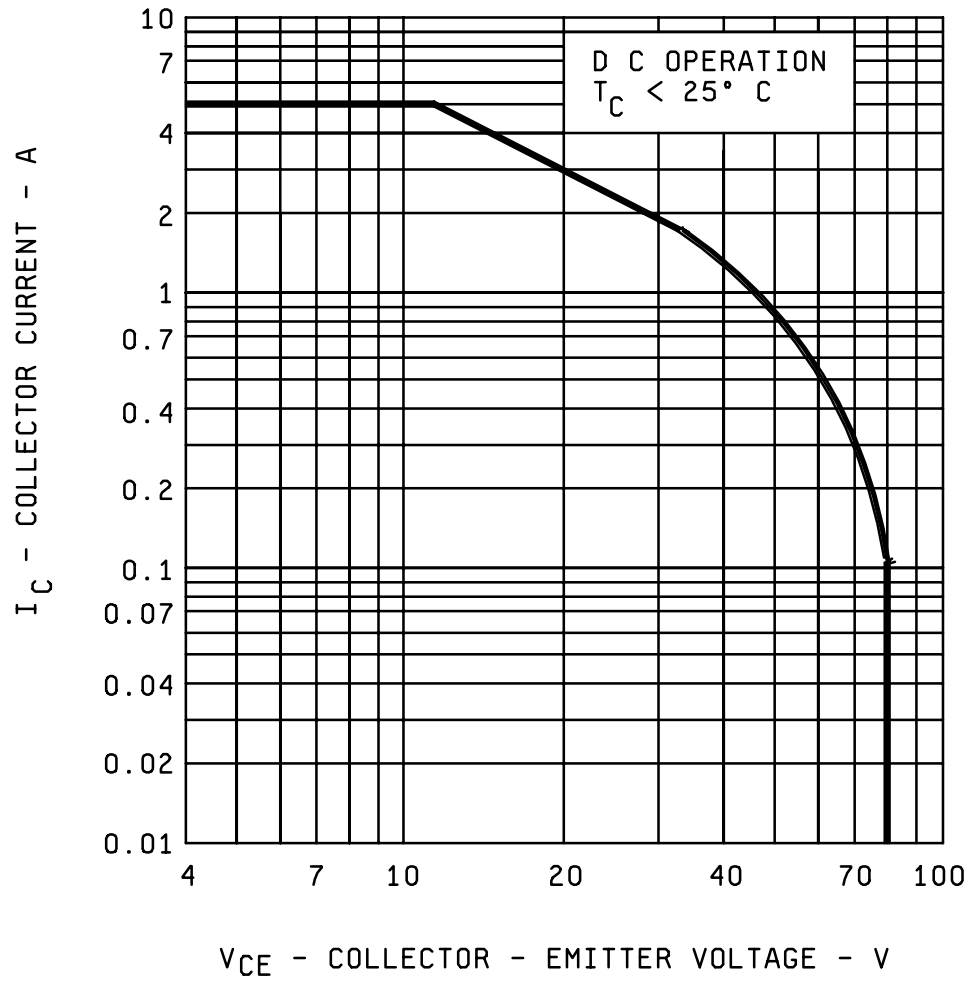


FIGURE 5. Maximum safe operating area.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. The acquisition requirements are as specified in MIL-PRF-19500.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers' List (QML) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000.

6.4 Complementary use. The devices specified herein are designed for complementary use with the 2N5003 and 2N5005.

6.5 Interchangeability information. The 2N5002 and 2N5004 (MIL-PRF-19500/534) are inactive for new design. For new design use 2N7373 (MIL-PRF-19500/613). MIL-PRF-19500/613 is a T0-254 package version of MIL-PRF-19500/534, which is a T0-210 (T0-59) package version. The military 2N7373 contains the same die as the military 2N5002 and 2N5004.

6.6 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N5002) will be identified on the QML.

| Die ordering information (1) | |
|------------------------------|------------------------------|
| PIN | Manufacturer |
| | 33178 |
| 2N5002 2N5004 | JANHCA2N5002 JANHCA2N5004 |

(1) For JANKC level, replace JANHC with JANKC.

6.7 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-19500/534C

2. DOCUMENT DATE
31 July 2001

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER TYPES 2N5002, 2N5004, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

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a. Point of Contact
Alan Barone

b. TELEPHONE

Commercial

DSN

FAX

EMAIL

614-692-0510

850-0510

614-692-6939

alan.barone@dscclia.mil

c. ADDRESS

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ATTN: DSCC-VAC
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